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Retrospective multicenter evaluation of the "fly-catching syndrome" in 24 dogs: EEG, BAER, MRI, CSF findings and response to antiepileptic and antidepressant treatment

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ABSTRACT

The fly-catching syndrome (FCS) is a rare canine condition of sudden, occasional, or constant episodes of biting the air. It may be accompanied by jumping, licking, and swallowing. The etiology of FCS is unknown and controversial. Various explanations for its occurrence have included epileptoid disorders such as visual cortex epileptiform disturbances and simple and complex partial seizures as well as compulsive disorders, hallucinatory behavior, and stereotypy. A retrospective multicenter analysis of 24 dogs with clinical symptoms of FCS is presented. Clinical signs at the time of presentation, the mean age at onset of the disease, the response to treatment, and the clinical outcome were recorded and analyzed in all patients. All dogs underwent clinical, neurological, and otoscopic examinations. Complete blood cell counts (CBCs) and serum chemistry panels were obtained from each dog. Diagnostic testing included MRI and EEG examinations in 21 cases, BAER in 19 cases, and CSF analysis in 20 cases. The EEG revealed spike activity in 8 (38%) of the 21 cases, 7 of which had activity in the occipital lobes. The brainstem auditory evoked response (BAER) revealed three cases of bilateral deafness. The MRI revealed six cases of Chiari malformation (CM), one case of syringohydromyelia (SM), and one case of a falx cerebri meningioma. The dogs were divided into groups according to their treatment protocol. Group A included dogs treated with phenobarbital (PB), and group B consisted of dogs treated with fluoxetine (FLX). Thirty-six percent of the dogs in group A responded to PB, while 100% of the dogs in group B responded to FLX. The results suggest that FCS is more responsive to FLX than PB. However, the etiology of this behavior remains unclear in most cases.

1. Introduction

The fly-catching syndrome (FCS) is a rare canine condition of sudden, occasional, or constant episodes of biting the air. It may be accompanied by jumping, licking, and swallowing. In the literature, it is also known as fly-snapping, fly-biting, fly-chasing, or jaw-snapping [1–4]. There have been numerous suggestions as to the cause of this disorder, including early development of vitreous opacity problems (synchysis scintillans) [4], peripheral neuropathy [2], visual anomalies and hyperactivity [5], and dietary allergy (meat) [6]. Recently, a gastroesophageal reflux (GER) similar to human Sandifer syndrome has also been suggested as a possible cause of the syndrome [7]. Currently, an epileptic or behavioral nature of FCS is considered to be most likely. Epileptoid disturbances leading to FCS have been reported to include epileptic discharges of the visual cortex, and they may result either from central nervous system (CNS) disease or from idiopathic epilepsy (IE) [3,8–13]. The FCS has also been cited to be a compulsive disorder, hallucinatory behavior, obsessive–compulsive disorder (OCD), stereotypy [1,9,14,15], or dyskinesia as an extrapyramidal disorder [13]. The Cavalier King Charles Spaniel (CKCS), Miniature Schnauzer (MS), and Greater Swiss Mountain Dog (GSMD) have been described as being predisposed to this condition [15], although many other dog breeds including the Doberman Pinscher, Airedale Terrier, Miniature Poodle, German Shorthaired Pointer, German Shepherd, Border Collie, Irish Setter, and the English Setter have also been found to display FCS [6,11,15–18]. The frequency of the episodes ranged from 30 per hour to once a week, and the age at onset ranged from 1 to 11 years [6,11,13,15,17,18].

Considering that FCS has been reported in the literature to have a variety of etiologies, functional (EEG, BAER) as well as structural (MRI, CSF) examinations should be considered when evaluating dogs with suspected FCS. Electroencephalography (EEG) is a noninvasive

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technique for the functional evaluation of the CNS. It is important as a diagnostic tool to confirm and monitor epilepsy in humans, but its practical relevance in animals remains unclear [19]. To date, an EEG assessment has not been carried out on a large group of animals with FCS. While the findings of specific diagnostic testing can guide one's treatment decisions, a patient's response to treatment can sometimes provide suggestive evidence of the etiology of a given behavior. Therefore, a good response to antiepileptic drugs (AEDs) suggests a possible epileptic origin. Given that antidepressant treatment (ADT) is considered as the medication of choice in the treatment of canine OCD [20], a good response of patients with FCS to ADT suggests that OCD may be its underlying cause. The purpose of this study was to retrospectively assess dogs with FCS from three different veterinary neurological centers by means of EEG, BAER, MRI, and CSF results. The dogs were also evaluated in terms of clinical signs at the time of presentation, the mean age at the disease onset, the response to treatment, and the clinical outcome following treatment.

2. Materials and methods

2.1. Case selection

The study included archived cases of 24 dogs with a record of FCS from three neurological centers collected between 2007 and 2012. All cases were referred for a neurological consultation. Eight cases were diagnosed at the Department of Internal Diseases with a Clinic for Horses, Dogs and Cats at the Faculty of Veterinary Medicine of the Wrocław University of Environment and Life Science, Poland; 12 cases were recorded in the Referral Animal Neurology Hospital Aisti, Vantaa, Finland; and 4 cases were identified at the Department of Internal Disease, Small Animal Clinic of the University of Veterinary Medicine, Vienna, Austria. Cases with a minimum of two recorded episodes of abnormal behavior, such as jumping, catching and swallowing imaginary objects, licking, and air snapping in a sudden, compulsive, episodic way corresponding to FCS that also had a documented medical history, were included in the study (case example: Videos 1 and 2). All dogs underwent clinical, orthopedic, neurological, and otoscopic examinations performed by certified neurologists (MW, SC, and AP). A CBC and serum chemistry panel (including urea, creatinine, glucose, cholesterol, TT4, cTSH, Na, K, Ca, Mg, GOT, GPT, CPK, albumin, total protein, preprandial and postprandial ammonia, and bile acids) were performed on the dogs. Twenty-one dogs underwent MRI and interictal EEG examinations. The brainstem auditory evoked response (BAER) was performed in 19 cases. Both electrodiagnostic examinations were performed under a medetomidine (20 μg/kg IM) sedation protocol. A visual EEG analysis was carried out to detect epileptiform activity in the form of paroxysmal discharges. A cerebrospinal fluid (CSF) cisternal puncture and analysis were carried out in 20 cases. The CSF examination included a cell count and Pandy's reaction, as well as a total protein and albumin quantification. Dogs treated with phenobarbital (PB) received it at a dose of 2–3 mg/kg PO BID. The PB serum level was measured at least 3 weeks after the initiation of therapy and varied between 23 and 32 μg/ml. Patients in group B received fluoxetine at a dose of 1-mg/kg PO BID. The therapeutic effect of antiepileptic (PB) and/or antidepressive treatment (FLX) was recorded for each dog. This was calculated based on the frequency of the FCS episodes reported by the owners. Therapy was considered to be effective when the fly-catching (FC) episodes were reduced by more than 50% within a three-month treatment period. These dogs were defined as “responders”. If an improvement was noted, but the number of fly-catching episodes remained greater than 50% of the initial number, treatment was considered unsatisfactory, and dogs were defined as “nonresponders”. The dose and frequency of use of each drug were recorded in each case. For the purpose of this study, patients were divided into three groups depending on the type of therapy received: group A included dogs treated with PB; group B contained dogs that received FLX; while group C consisted of dogs under therapy different from that in groups A and B. Because of the heterogeneity of treatment received by dogs in group C, only groups A and B were compared statistically.

2.2. Statistical analysis

Data regarding the efficacy of the therapy were analyzed statistically. Because of the lack of uniform information about the clinical status of all the animals during and after treatment in this multicenter study, binary data were assessed, applying the chi-square test for differences among more than two proportions (comparison of the response to treatment and comparison of the occurrence of EDs between groups). The difference between the treatment results was considered statistically significant if $p < 0.05$.

2.3. Ethics committee approval

The study protocol was approved by the Regional Ethics Committees for Animal Research (permit number 106/2010).

3. Results

The study included 24 cases, of which 10 were CKCS and the remaining dogs were of different breeds (American Staffordshire Terrier, Boxer, Cocker Spaniel, Dachshund, Dalmatian, French Bulldog, German Shepherd, German Shorthaired Pointer, Jack Russell Terrier, Miniature Schnauzer, Portuguese Sheepdog, Pyrenees Dog, West Highland White Terrier [WHWT], and mixed breed). The age at onset of the symptoms was between five months and 12 years of age (median: 24 months, mean: 35 months). Seventeen males and seven females comprised the study group. In 4 dogs, the owners reported additional behavioral disturbances including excessive licking in the air (one WHWT); face, neck, and ear scratching; paw licking; excessive tail-chasing; head shaking; and hind-limb biting (three CKCSs). Two dogs (CKCS) had a history of external otitis, and one had a history of food allergy. The clinical, orthopedic, and otoscopic examinations did not reveal abnormalities in any of the dogs. The neurological examination revealed a slightly bilaterally reduced menace response in five cases (JRT, schnauzer, 3 CKCSs) and a slight head tilt to the right (one American Staffordshire Terrier). No abnormalities were recorded in the CBC and serum chemistry analysis. The BAER examination revealed two cases of bilateral sensorineural deafness (American Staffordshire Terrier and Dachshund) and one case of bilateral age-related deafness (presbycusis in a 12-year-old German Shepherd [GSH]). Of the 21 dogs that underwent MRI of the head, two cases (Boxer and CKCS) had a mild lateral ventricular asymmetry, six CKCSs (Chiari malformation; CM) had mild occipital bone hypoplasia, one of the CKCSs had mild syringohydromyelia (SM), and the GSH had a small meningioma (3/5 mm in diameter) of the right falx cerebri. In all dogs, the CSF examination did not reveal any pathological abnormalities (cell count < 5 μl, TP < 25 μg/dl). The summary of the history, examination results, initial diagnosis, and treatment results of all analyzed patients is presented in Table 1.

Group A ($n = 11$) consisted of cases initially treated with PB. Four (36%) dogs responded to treatment, whereas seven (64%) dogs were classified as nonresponders. Group B ($n = 11$) included dogs initially treated with FLX, two cases from group A that did not respond to PB, who subsequently underwent FLX therapy, and one case that was initially treated with gabapentin (GB) that later received GB and FLX and eventually received solely FLX. In this group, 11 (100%) dogs were responders. There was a statistically significant difference in the response of the dogs to treatment between groups A and B ($p < 0.05$).

Group C ($n = 6$) consisted of patients treated with a combined therapy that could not be compared due to the heterogeneity of treatment. It included two dogs that were responders to a combined PB, FLX, and CAR treatment (cases 22 and 10), one GB and FLX-responder (case 18),

Table 1
Summary of the history, MRI, EEG examinations, and treatment.

Case number	Breed	Age at onset (m)	Gender	History	MRI	EEG	End diagnosis	Treatment summary	Treatment end effect	Treatment group
1	Boxer	48	M	FCS and focal and complex partial seizures	Asymmetric lateral ventricles (L > R)	Spikes T and O	IE	PB	PB responder	A
14	Dalmatian	42	M	FCS and seizures	Normal	Normal	IE	PB	PB responder	A
9	Pyrenees dog	108	F spayed	FCS	Normal	Spikes bilat. O	IE	PB	PB responder	A
19	French Bulldog	55	M	FCS	Normal	Spikes bilat. F	IE	PB	PB responder	A
15	Schnauzer	16	F	FCS	Normal	Spikes Rt. O and P	IE	PB	PB nonresponder	A
13	JRT	24	M	FCS	Normal	Spikes bilat. O	IE and OCD	PB	PB nonresponder	A
21	CKCS	12	M	FCS	n/a	Normal	OCD	PB	PB nonresponder	A
7	Cocker Spaniel	12	M	FCS	Normal	Normal	OCD	PB — no effect, then FLX	PB nonresponder, FLX responder	A and B
23	Mixed breed	10	F	FCS	Normal	n/a	OCD	PB — no effect, then FLX	PB nonresponder, FLX responder	A and B
3	CKCS	12	F	FCS	CM, mild ventricular enlargement	LVHA	OCD	FLX	FLX responder	B
4	CKCS	41	M	FCS, focal seizure, history of otitis externa	Slight CM	Normal	Mild CM, OCD	FLX	FLX responder	B
11	CKCS	24	M	FCS	Normal	Spikes bilat. O	OCD	FLX	FLX responder	B
16	CKCS	71	M	Episodic FC, neck and ears scratching, and paw biting	Asymmetry of lateral ventricles with right one enlarged, CM	Spikes Lt. Ct, O	OCD	FLX	FLX responder	B
17	CKCS	11	M	Excessive tail-chasing, FC and scratching the neck, and head shaking	Mild CM	Normal	Mild CM, OCD	FLX	FLX responder	B
20	Portuguese Sheepdog	5	M	FCS after playing or when calm, increase by stress	Normal	Normal	OCD	FLX	FLX responder	B
24	CKCS	12	M	FCS	n/a	n/a	OCD	FLX	FLX responder	B
8	WHWT	10	F	FCS, excessive licking	n/a	Normal	OCD	FLX	FLX responder	B
5	CKCS	28	M	FCS, food allergy, and otitis externa	CM and slight SM	Normal	CM + SM, OCD	GB — no effect, then GB + FLX, improved, after 5 m only on FLX — improved	FLX responder	B
18	CKCS	7	M	FCS, progressive behavior abnormality, scratch on the face, hind-limb biting	Mild CM and SM	Normal	SM and hypersensitivity, OCD	GB — no effect, then GB + FLX	GB + FLX responder	C
12	GSH	144	F spayed	Deafness, FCS	Meningioma, Rt. falx cerebri side, approximately3/5 mm	Normal	OCD, meningioma-induced, presbycusis	DZ — no effect, then DZ + FLX	DZ + FLX responder	C
22	German Shorthaired Pointer	12	M	FCS	Normal	n/a	OCD	PB — no effect, then PB + FLX + CAR	PB nonresponder, PB + FLX + CAR responder	A and C
10	CKCS	48	M	FCS	Normal	Spikes bilat. O	OCD	CLOMI — no effect, then PB + FLX + CAR	PB + FLX + CAR responder	C
2	American StaffordShire Terrier	36	M	FCS	Normal	Normal	Deafness, OCD	PB, no effect, then PB + FLX — no effect	PB nonresponder, PB + FLX nonresponder	A and C
6	Dachshund	60	F spayed	FCS	Normal	Normal	Deafness, tinnitus, and OCD	AMI — no effect, then FLX + GB	GB + FLX nonresponder	C

Legend (alphabetically): A: group A under PB treatment; AMI: amitriptyline; B: group B under FLX treatment; bilat.: bilaterally; C: group C under PB and FLX treatment; Ct: central lobe; CAR: carbamazepine; CKCS: Cavalier King Charles Spaniel; CLOMI: clomipramine; CM: Chiari malformation; DZ: diazepam; EEG: electroencephalography; F: frontal lobe; FCS: fly-catching syndrome; FLX: fluoxetine; GB: gabapentin; GSH: German Shepherd; IE: idiopathic epilepsy; JRT: Jack Russell Terrier; Lt.: left; m: months, LVHA: low-voltage high amplitude; MRI: magnetic resonance imaging; n/a; not acquired; O: occipital lobe; OCD: obsessive–compulsive disorder; PB: phenobarbital; Rt.: right; SM: syringohydromyelia; T: temporal lobe; WHWT: West Highland White Terrier.

one DZ and FLX-responder (case 12), and two PB and FLX-nonresponders that also did not respond to GB and FLX (cases 2 and 6).

In group A, two dogs had a history of seizures (focal, complex partial, and generalized tonic–clonic) in addition to the FC symptoms. In five cases, the EEG examination revealed spike activity in the temporooccipital, occipital, and frontal derivations. None of the PB nonresponders from group A had a history of clinical seizures. In two of the seven nonresponders, EEG revealed spikes (occipital and parietal lobes). One PB nonresponder (case 2) was diagnosed with bilateral sensorineural deafness. The MRI in group A did not reveal any clinically relevant changes.

One dog in group B (9%) had signs of focal seizures (facial twitching) as well as FCS (case 4). The EEG revealed anomalies in the form of spikes in 2 cases localized in the centrooccipital and occipital areas (Fig. 1), while one dog had generalized low-valence high-arousal (LVHA) activity. All three cases that had abnormal EEG recordings were CKCS that responded to FLX, two of which had CM and ventriculomegaly.

In group C, one dog (case 12) was diagnosed with a small meningioma concomitant with presbycusis. In this group, the BAER examination revealed bilateral sensorineural deafness in both nonresponders (cases 2, 6). In group C, none of the dogs showed clinical seizures. However, the EEG examination revealed occipital spikes in case 10.

4. Discussion

Although the first reports of fly-biting behavior appeared in 1962 [4], FCS in dogs is still poorly understood, and its frequency is unknown. The etiology of this behavior is controversial and has been reported as epileptoid disorders of the visual cortex or simple and complex partial seizures as well as compulsive disorders, hallucinatory behavior, and stereotypy. On the one hand, there are cases reporting FC behavior combined with evident epileptic seizures (e.g., generalized tonic–clinic seizure [GTCS]) [10–12]. On the other hand, the literature describes dogs exhibiting FCS, without evident epileptic seizures, with additional behavioral disturbances including licking of the paw and floor, running into objects, lying in the yard and crying, eating mud, following the owner, biting family members without any apparent reason, defecating on the bed [2], or biting and sucking their hindlimbs and pelage [7]. In our study of 24 dogs, only three dogs had evident focal and partial seizures (cases 1 and 4) or GTSC (case 14) based on the owner's description of the episodes. Behavioral disturbances other than FC that were observed in the dogs in this study included excessive paw licking and biting (one WHWT), neck and ear scratching, hindlimb biting, and excessive tail-chasing (two CKCSs). These behaviors could not be clearly classified as of epileptic — or OCD origin. In the CKCS, these behaviors have very often been described as a clinical presentation of CM [15], which was observed in a mild form in both CKCS dogs in this study.

In our group, the median age of FCS onset was 24 months. Overall and Dunham reported that the mean age of OCD onset in dogs was under 2 years of age [14]. Very commonly, this is also the age at onset of seizures of epileptic origin [13,19]. Therefore, these data are not specific and should not be considered when differentiating between an epileptic nature and OCD nature of the disorder.

The CKCS, MS, and GSMD are breeds reported to be predisposed to FCS [17]. The present study included ten CKCSs and one MS. Of the eight CKCSs that underwent MRI, two showed no abnormalities. This supports the speculation that FC occurs in the CKCS because of general breed-specific CNS structural anomalies and may be a part of the cerebral syndrome. A case report of a toy fox terrier with CM and FC symptoms that did not respond to PB may support the suspected correlation between these two neurological conditions [8]. On the other hand, MS and GSMD are breeds that do not have predispositions to intracranial structural disorders but exhibit FC behavior. A correlation between thrombocytopenia and macrothrombocytosis in the CKCS and the occurrence of FCS have also been suspected [21]. Secondary cerebral circulation damage has also been suggested as a possible cause of this behavior. Some reports present individual cases of FCS, while others focus on describing this phenomenon as a manifestation of a given CNS pathology [19]. The FCS combined with seizure activity was also observed in other cases of vascular pathology [22]. The MRI analysis in the present group did not reveal any vascular pathology, although MR sequences that reflect vascular pathology were not carried out in any of

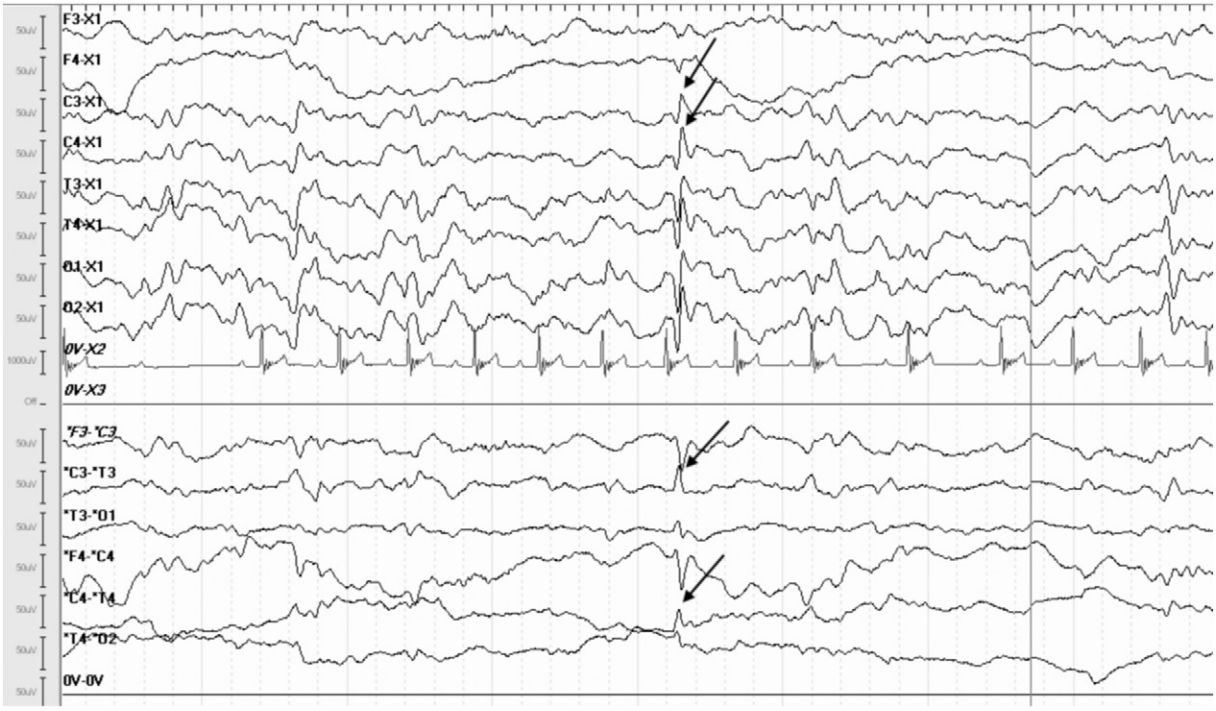

Fig. 1. Electroencephalograph of a dog with clinical FCS. Monopolar montage: F3–X1, F4–X1, C3–X1, C4–X1, T3–X1, T4–X1, O1–X1, and O2–X1, reference (X1) at the vertex, bipolar montage: F3–C3, C3–T3, T3–O1, F4–C4, C4–T4, and T4–O2, (F, frontal; T, temporal; C, central; O, occipital; odd numbers = left hemisphere; even numbers = right hemisphere), electrocardiography (OV–X1). Bilateral spike activity is shown in the central area (arrows).

the dogs. The MRI examination, which was carried out in 20 of the 24 dogs, revealed a small meningioma in one dog, CM in six dogs, and SM in one dog. A neuropathological examination was not performed on these dogs. Gross pathological changes of the CNS were excluded in the remaining dogs.

Fly-biting stereotypy preceding a generalized tonic–clonic seizure (GTCS), described in an intoxicated setter dog, resolved after treatment of the intoxication [11]. In that case, an EEG revealed intermittent bursts of EDs with clinically apparent facial motor activity. The FCS defined as partial motor seizures was described in two Irish setters with globoid cell leukodystrophy [10]. Based on the aforestated cases, one should take into consideration that epileptic facilitation may cause FCS and that its etiology may vary.

Electroencephalography is a noninvasive functional evaluation of the CNS [23,24] and may differentiate epilepsy from a nonepileptic disorder such as behavioral or compulsive disorders. Although EEG has special diagnostic importance for epilepsy in humans, it has been relatively rarely used for the differentiation of CNS diseases in veterinary medicine [19,25–27]. The epileptiform discharges (EDs) recorded on EEG in dogs include the following: spikes, sharp waves, spike-slow waves, polyspikes, and polysharp waves [28,29]. In the current study, epileptic discharges (EDs) of spikes were detected in 8/21 (38%) cases, though recordings were not obtained during fly-catching episodes. Nonepileptic, generalized low-valence high-arousal (LVHA) activity, which we consider to be caused by concomitant ventriculomegaly, was found in one CKCS. There are very few reports of EEG findings in dogs displaying FCS. The EEG of one of the eight dogs with FCS described in 1979 revealed no particular changes [2]. In our group, EDs were most commonly ($n = 7$) localized in the occipital lobes. This may support the theory that temporooccipital partial seizures or epileptiform hallucinations do appear in dogs exhibiting FC. The EEG activity found in 38% of the dogs in this study included focal spikes. The presence of focal spikes can be seen in healthy human persons (0.5–4%) [23]. In epileptic dogs, EEG detectability of EDs varies from 12.5% to 100%, although it has not been reported in healthy dogs [28,30]. In our study, three of the four PB responders and two (18%) of the eleven FLX responders displayed spikes in the EEG. One dog that did not have any EEG abnormalities was diagnosed with FCS combined with GTCS (case 14). The number of dogs in this study is too small for the presented data to have definitive statistical values. However, these findings may be noted for future research.

Studies reporting dogs with FCS episodes that precede a GTCS suggest this behavior to have an epileptic nature [11]. However, simple partial or complex partial seizures may be misinterpreted as OCD. During such an episode, the animal does not lose consciousness, and focal motor or sensory signs are observed [9,31]. The epileptic nature of FCS has also been explained as hallucinatory behaviors due to visual cortex disorders [13]. Since sensory disturbances cannot be truly identified in animals, a differentiation between the epileptic and the OCD nature of FCS is difficult to establish. The exact description of the animal's response to its surrounding environment during an FCS episode may aid in distinguishing the two conditions. Obsessive–compulsive disorder can usually be modulated by distracting the animal using external stimuli (example Video 2), and a postictal period is not observed [13]. Exceptions to this generalization are possible. Most of the reported animals in this study were found to exhibit FCS behavior while being fully alert, which is characteristic of OCD, but does not exclude partial seizures [13]. Dogs in this study appeared to respond to the FLX protocol better than dogs receiving PB treatment (100% in group B vs. 36% in group A). Experimental medicine has revealed a strong effect of antidepressants on the frequency of seizures [32,33]. However, we suggest considering the OCD nature of the FC behavior in cases with no seizure activity.

The BAER examination revealed sensorineural deafness in two cases and age-related deafness in one case (presbycusis). Both dogs with sensorineural deafness did not respond to either chemical or behavioral forms of treatment and were eventually euthanized by the owners due to excessive FC symptoms. These dogs were found to have the most severe symptoms of all the dogs included in this study. The comorbidity of OCD and deafness has been described in a population of human patients with tinnitus [34]. Although we can only speculate whether their FC behavior was a form of OCD as a result of their hearing impairment, carrying out a BAER in dogs exhibiting FCS is definitely recommended.

Different FC treatment protocols have been proposed in the literature. Trials using AEDs, including treatments with PB, primidone, diazepam, mephobarbital, and diphenylhydantoin, showed no rewarding results [2,6,12,13,15]. One case of a Bernese Mountain Dog (BMD) with complex partial seizures combined with other neurological symptoms, including FC, was shown to periodically improve with huperzine A treatment [12]. This drug is a compound isolated from Chinese club moss with an NMDA receptor-blocking activity, anticholinesterase activity, and anticonvulsant properties [35]. Phenobarbital was found to be ineffective in the treatment of FCS in the CKCS [1,15]. The FCS was suspected to be a form of OCD in the CKCS by Rusbridge, and a PB therapy was proposed, followed by ADT (FLX or clomipramine) combined with behavioral training, if the former was unsuccessful [15]. However, to date, there is no specific therapeutic protocol involving this treatment option. In humans, the use of SSRIs gives a high success rate in the treatment of OCD [36]. In our study, the group treated with FLX responded significantly better to treatment compared with the dogs treated with PB. Fluoxetine is a SSRI drug and was shown to be effective in a randomized, controlled clinical trial in dogs with diagnosed OCD [20]. However, one should remember that SSRI can also act to reduce seizure frequency, and improvement using this drug does not eliminate the epileptic etiology of the syndrome [37].

Two dogs (CKCS) also received GB, and one dog (GSH) received DZ for a short period of time. These drugs alone did not reduce FC symptoms. Tricyclic antidepressants (clomipramine and amitriptyline) were used in two cases with no effect, but a definitive assessment of the usefulness of those drugs cannot be made.

Based on the retrospective analysis of 24 dogs and literature data, it is advised to perform several diagnostic procedures in order to determine medical, neurological, and behavioral disorders that may cause FCS (Table 1). We suggest carrying out EEG recordings in dogs exhibiting FCS in order to evaluate EEG data in FCS more comprehensively. If it is not possible to perform an EEG recording and based on the findings of this study that PB seemed less effective at treating the FC behavior than FLX, a 4- to 6-week trial of FLX at a dose of 1-mg/kg BID treatment is recommended. If the animals have a concomitant history of seizures and FCS, routine epilepsy diagnostics and an adequate therapy ought to be implemented.

4.1. Study limitations

A double blinded, placebo-controlled trial would be of more value in assessing the usefulness of FLX in the therapy of FCS. However, the rareness of this syndrome makes such a study extremely hard to perform.

5. Conclusion

The underlying cause is likely to vary among dogs with FCS. Therefore, thorough diagnostic testing should be performed in order to exclude any obvious CNS pathologies. However, it may be difficult to differentiate between OCD and epilepsy in many cases. Most of the presented cases in this study showed satisfactory improvement with FLX treatment.

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.yebeh.2015.10.013.

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Conflict of interest

The authors declare that they have no conflict of interest in connection with this work.

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